AIR FORCE STUDIES
AND ANALYSES AGENCY

Tactical Data Link Gateways Introduction

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December 1999
Force Analysis Division

SAMI Number: 31494

UNCLASSIFIED

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	22 December 1999	Summary and Annotated Brief - 30 July 1999

4. TITLE AND SUBTITLE

Tactical Data Link Gateway Introduction - Executive Summary and Annotated Brief

5. FUNDING NUMBERS

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Air Force Studies and Analyses Agency
1570 Air Force Pentagon
Washington DC 20330-1570

8. PERFORMING ORGANIZATION REPORT NUMBER

31494

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

AC2ISRC, Langley AFB, VA 23665

AF/XPX and AF/XOC, Air Force Pentagon, Washington DC 20330

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT

This publication is Unclassified and Approved for Public Release:
Distribution Unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

At the February 1999 Air Force Board meeting, AC2ISRC briefed a Tactical Data Link (TDL) roadmap that used gateways between current and future TDLs. Approval of the roadmap was deferred, pending more information, which is supplied in this TDL Gateway Introduction requested by AF/XPPI. Gateways provide a conduit for data and information sharing, enabling battle space visualization. Prior to gateway implementation, it is vital to understand the inormation exchange requirements, their context, the systems providing data and information, the mission's intended information use, and the TDL environment. Recent Advanced Concept Technology Demonstrations (ACTDs) have shown quantified value-added by sharing specific Army ground data between Variable Message Format data link participants and Link 16 participants via tailored gateways. The Expeditionary Force Experiment (EFX) series in FY98 and FY99 showcased various TDL gateway demonstrations to share information among intelligence gathering platforms and operational platforms to improve mission performance. All stakeholders in the data link architecture, from the engineers who implement the data link system to the operators using them, need to understand the impact of the gateway on the architecture. With careful planning, using detailed network knowledge, and an effective training program, gateways can bridge separate TDLs. By designing and installing appropriate, dynamic filters, TDL gateways enable warfighters to access information rapidly, completely, and accurately; information that would otherwise have to be communicated over voice channels. TDL gateways are expected to improve mission performance. Quantifying expected improvements requires data collection, study, and dissemination.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Gateway, Tactical Data Link, TDL, Data Link, Advanced Concept Technology Demonstration, ACTD, Expeditionary Force Experiment, EFX, Link 16, Variable Message Format, VMF, Voice Communication, Communication, Data Link Architecture, Architecture, Network	16
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

Standard Form 298 (Rev. 2-89) (EG)
Prescribed by ANSI Std. 239.18
Designed using Perform Pro, WHS/DIOR, Oct 94

THIS REPORT HAS BEEN APPROVED FOR PUBLICATION	
Analyst / Study Director:	AFSAA Chief Analyst:
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FOR THE COMMANDER	

Title: Tactical Data Link Gateways Introduction

- *This brief was requested by Col Jones, AF/XPPI, following a February 1999 Air Force Board briefing on the Tactical Data Link Roadmap by AC2ISRC. One of the pillars of the Tactical Data Link Roadmap is gateways, which allow sharing of specific, planned information between different networks.*

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Executive Summary
TACTICAL DATA LINK GATEWAYS INTRODUCTION

Purpose

Tactical Data Link (TDL) gateways may improve operational effectiveness and save money. Recent Advanced Concept Technology Demonstrations (ACTDs) and Joint Experimental Force Exercises (JEFX) have showcased TDL gateways to extend digital connectivity to quickly transfer mission critical information. This paper provides a summary description of TDL gateways.

Background

In February 1999, at Air Force Board (AFB) meeting, the Aerospace Command and Control & Intelligence, Surveillance and Reconnaissance Center (AC2ISRC) briefed a tactical data link (TDL) roadmap, which introduced the concept of gateways between most of the current and future TDLs, used by the Air Force. Approval of the data link roadmap was deferred pending more information. Col Cecil Jones, AF/XPPI, chose AFSAA to build a brief for the AFB in July 1999 to explain what gateways are and how they are required to support situation awareness and information exchange in future military operations.

Gateways are software implementations on new or existing hardware that allow dissimilar or otherwise incompatible systems to communicate with each other. Like a master translator, gateways allow different TDLs to convert and swap information between their information environments. This expands the information about the battlespace available to the warfighters. Increased situation awareness, in air to air and air to ground missions can lead to increased lethality and survivability due to less time spent on administrative tasks such as verbal communications of friendly and enemy locations. Increased situation awareness of the entire battlespace also yields a higher probability that appropriate ordnance will be used at the right time on the right target. In researched studies and documented operational assessments, TDLs improved warfighting performance from 0% to 100%, depending on the scenario.

Scope

The original development plan for the gateway brief called for investigation of both SEAD and CAS vignettes. Investigation revealed tremendous overlap in these areas, so the effort concentrated on the CAS vignette alone. For the CAS area, AFSAA used the Air Force Concept of Link 16 Employment (COLE) document [currently the Concept of Link Employment], AC2ISRC fielding plans, and current documented implementation of digital data and voice links on the battlefield.

Discussion

A gateway provides a conduit for data/information sharing and battle space visualization between separate information environments. A gateway may be software only, or hardware with software. As hardware, it may be a stand-alone laptop computer or a physical card inserted into another computer on a host platform. Data link transmission/reception hardware is required for both the sending and receiving networks to which the gateway is attached. The information can then be shared among the participants in all of the connected networks. Gateways exist in fielded systems such as the Air Defense System Integrator (ADSI) and the Modular Control Equipment (MCE) in the Ground Theater Air Control System (GTACS). A challenge in maintaining these gateways is specialized and proprietary software, which is expensive to updateand manage.

Recent advanced concept technology demonstrations (ACTDs) have shown the value of sharing specific Army ground information between Variable Message Format (VMF) data link participants and Link 16 participants via a gateway. The Expeditionary Force Experiments (EFXs) in FY98 and FY99 showcased TDL gateway demonstrations for future theater operations.

Prior to gateway implementation, it is vital to understand the information exchange requirements, their context, the mission, and the data link environment. If information exchange requirements require a gateway within the overall data link architecture, all stakeholders in that architecture – from the engineers who are implementing the data link systems to the operators using them – need to understand the impacts of the gateway on the architecture.

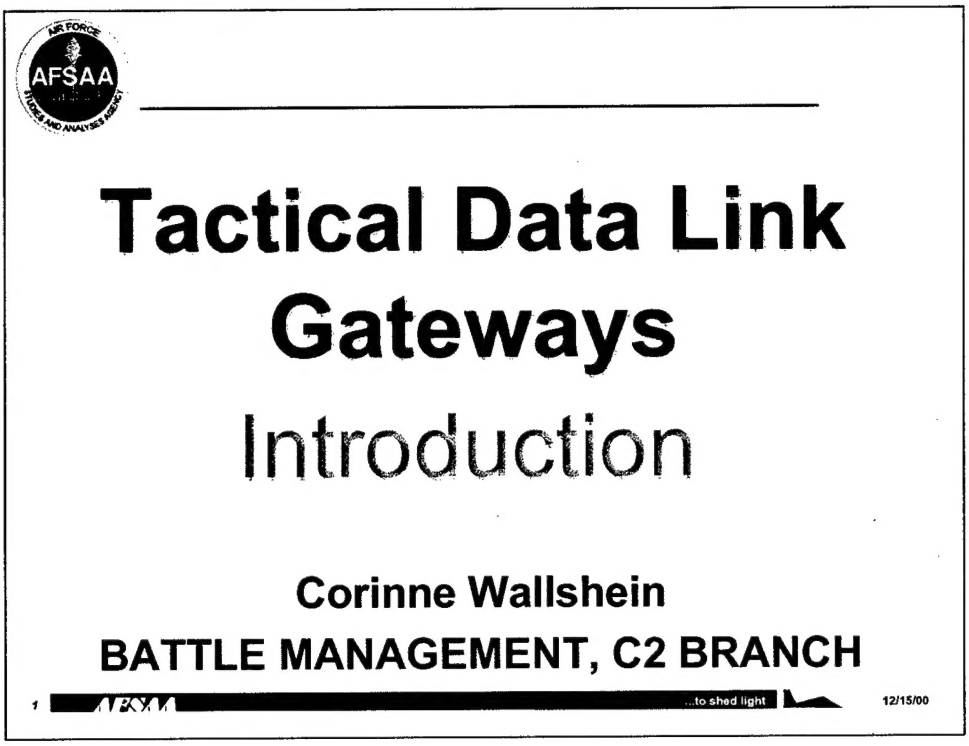
Building a framework for future gateway implementation requires understanding the network information elements, data refresh rates, transmission protocols, and message standards. Only with careful planning, using detailed network knowledge, can gateway implementations effectively bridge separate TDLs. By designing and installing appropriate, dynamic filters between the TDLs, gateways enable warfighters to access situation awareness information, combat identification (CID) information, threat data, etc. rapidly, completely, and accurately that would otherwise have to be communicated via voice channels. Gateways facilitate improved information flow by passing mission data across existing networks; however, the network managers must manage the risk of network overload in real time.

Summary

Gateways allow information sharing and promote visualization of the battle space among friendly forces, enhancing situation awareness. Performance enhancements from past studies and operational assessments have quantified effectiveness improvements ranging from 0% to 100%, depending on the mission, with the employment of digital data links. Improvements include lower fratricide levels and higher percentages of bombs on target.

As a result of the 30 July 1999 briefing to the AFB, AC2ISRC is establishing a consolidated Air Force tactical data link gateways program. Current efforts, as of December 1999, include drafting a comprehensive operational requirement document, drafting a consolidated gateway concept of operation, and seeking the required funding in the FY02 POM.

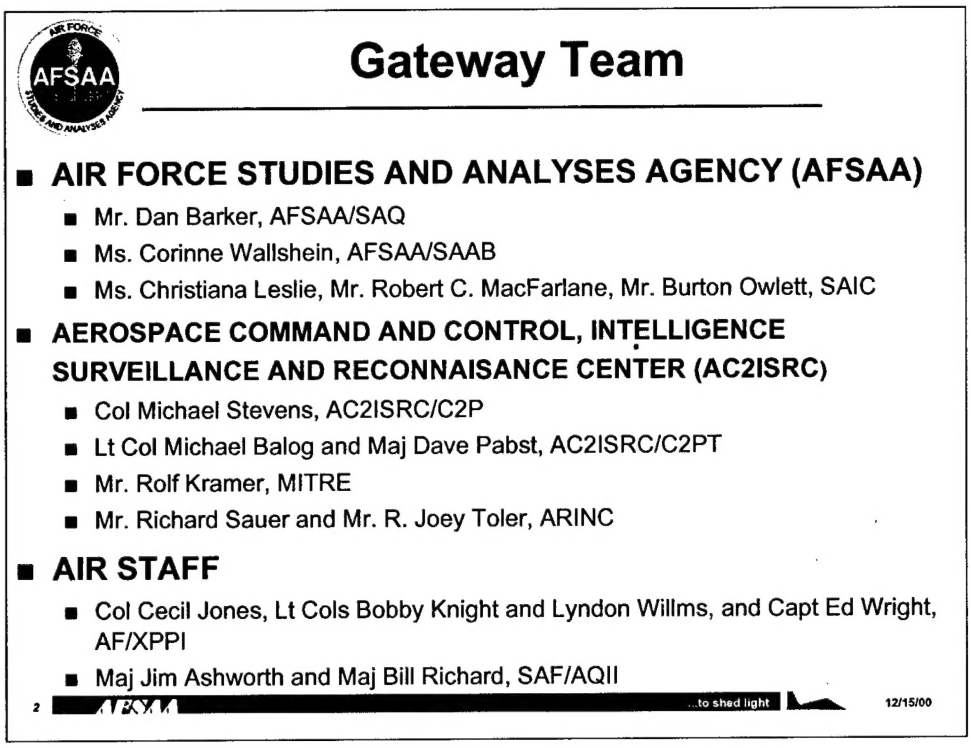
While this brief was being staffed, the Fiscal Year 1999 Kosovo Supplemental Additional Requirements listed the Link 16/Rosetta Gateway ACTD as the number one priority. $13.7 million was earmarked for Link 16 communications interoperability, especially for the Army and Apache helicopters. This gateway was to provide interoperable communications between Link 16, EPLRS, VMF, and SADL equipped units for current in-theater equipped units and for units deploying to the theater. Balkan theater information throughput to the Combined Air Operations Center and to warfighting units in the air and on the ground was expected to significantly improve as a result of this connectivity.



AF/XPPI asked AFSAA to build an introduction to Gateways brief for presentation to the Air Force Board in the summer of 1999.

Col Jones, XPPI, asked for this presentation to be built after a February 1999 Air Force Board briefing on the Tactical Data Link (TDL) Roadmap, briefed by the AC2ISRC, which generated many questions on the gateway topic. One of the pillars of the roadmap is TDL gateways. Gateways allow the sharing of specific, planned information between different networks.

This brief was followed by Maj Dave Pabst in the AC2ISRC. He presented a proposal to establish a TDL gateways program office.



Here are the main participants in this effort. Names from the same organization were alphabetized. Almost all the data in this brief was supplied by AC2ISRC.

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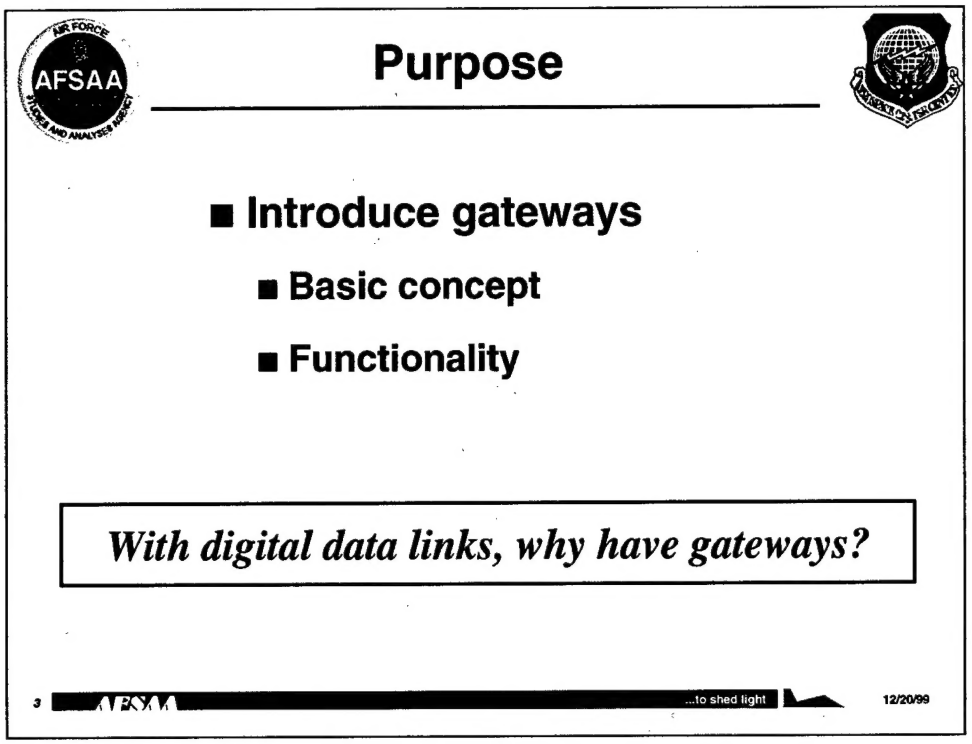
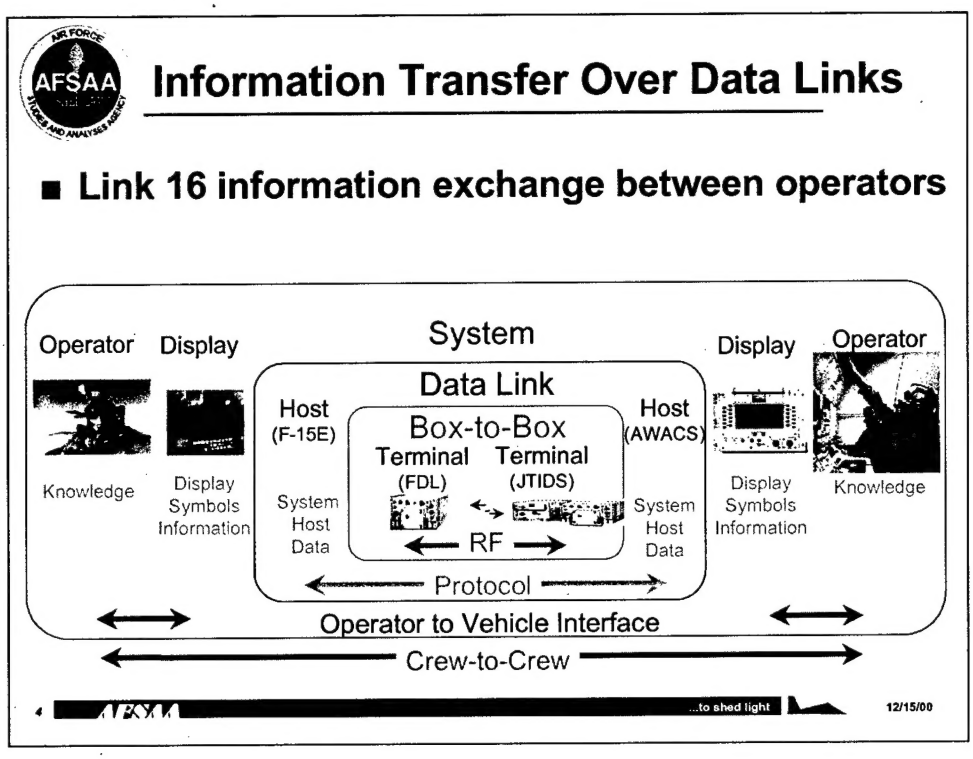


The purpose of this brief is to:

- Introduce gateways
    - Basic Concepts
        - What a gateway physically and logically is
        - Gateway terms
    - Functionality
        - What a gateway can provide
        - What a gateway can do for information exchange

The reason for this briefing is to answer the question:
With digital data links, why have gateways?

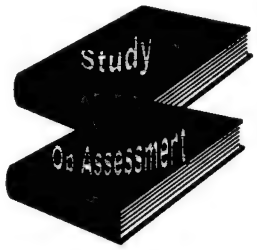


This picture is an example where we have a data link and we don't need a gateway. There are only three levels shown here -- the box-to-box, the data link and the system. The **box-to-box** can be thought of as the **digital communications** component; the **data link** as the protocol of **converting** the digital communications **to information** using the appropriate message standard; and the **system,** which includes the **display devise** terminal and the **operator,** to pass knowledge from the operator around the battlefield. A gateway, if added, would usually be inserted at the data link level to translate information to the digital, automated display. ***The intent of this diagram is to show that you can have different terminals (JTIDS, MIDS, FDL, etc.) and different hosts (U.S. F-15, AWACS, and F/A-18 or NATO F-3) and have interoperability because they're all using Link 16.***

Tactical data links involve transmissions of bit-oriented digital information which are exchanged via tactical digital information links or Tactical Digital Information Links (TADILs). **A TADIL is a Joint Chiefs of Staff (JCS) approved standardized communication link suitable for transmission of machine-readable, digital information.** TADIL J is known in NATO as Link 16 and provides technical and operational improvements recommended from older TADILs. Link 16 provides such improvements as: jam resistance, improved security, *increased* data rate, increased amount/granularity of information exchange, reduced data terminal size (to allow installation in fighter and attack aircraft), relative navigation, precise participant location and identification.

Data Link Benefits

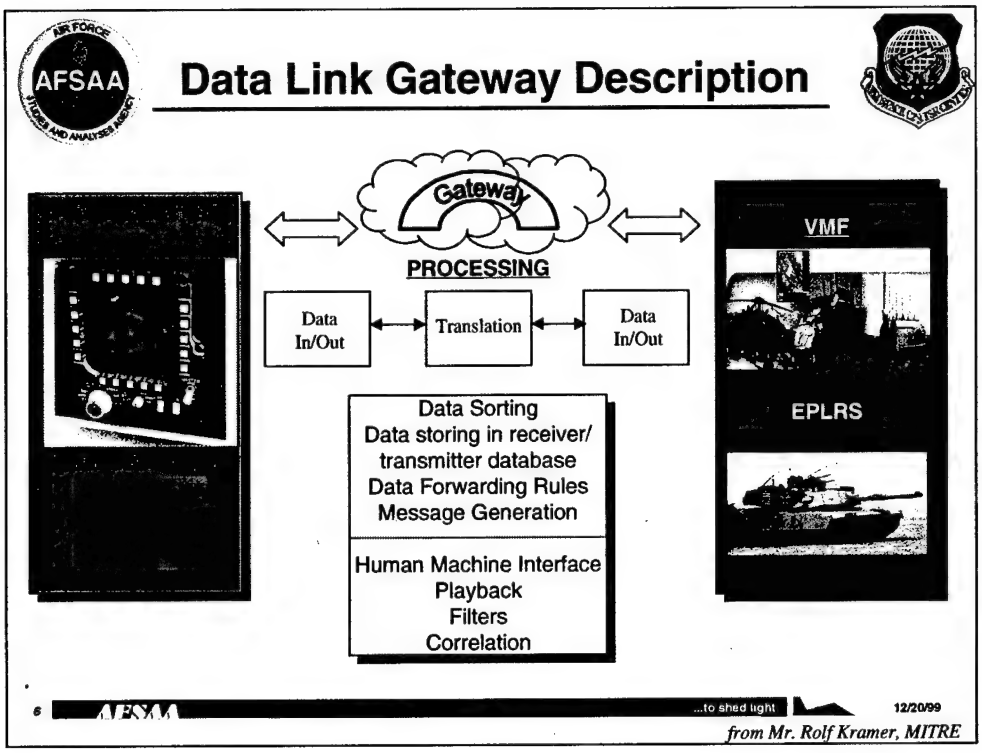
- **Digital data links proven to be:**
  - **More effective**
    - **Increased situation awareness**
      - **Less time to rendezvous**
      - **Knowledge of battle space**
    - **Increased lethality**
      - **Bombs on target**
  - **More efficient**
    - **Less time on administrative tasks**
    - **Less missiles and less fuel used**
  - **More survivable**
    - **Lower fratricide**



based on past studies and operational assessments

Data links provide an increase in situation awareness by allowing information from systems that are otherwise incompatible to communicate with each other. This allows more complete information to be exchanged about the battle space. The better the information, the increased chance of hitting the appropriate target. If you have better information about where the target is, you will waste fewer missiles and fuel, you will target more effectively to have more bombs on target, and you will spend less time on administrative tasks with their accompanying verbal affirmations of friendly and enemy locations, since you will have a digital display with combat identification markers for the viewed forces. If friendly locations are shown on a digital display, then the chance of fratricide is reduced, which increases survivability.

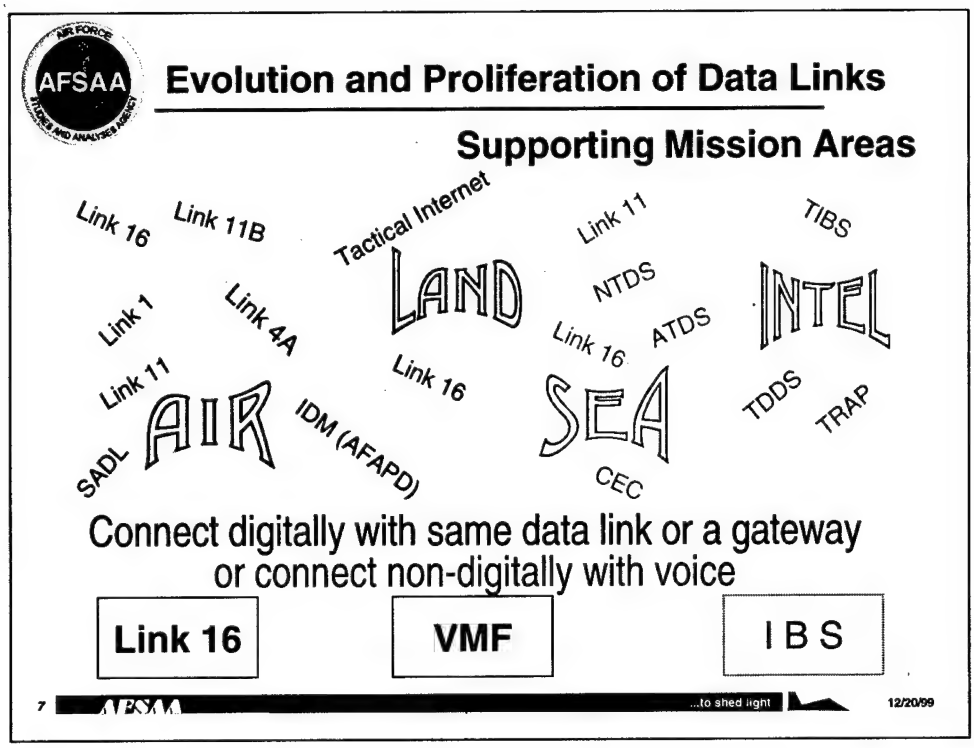
Rendezvous can be a fighter or bomber aircraft with a tanker, or a 2-ship or 4-ship joining with other 2-ships or 4-ships to make a strike package to accomplish an air-to-ground mission.



In the above example, Link 16 on an F-15E aircraft would interface with Enhanced Position Location and Reporting System (EPLRS), using Variable Message Format (VMF) messages, on an Army tank via a gateway. Message formats would be converted through a gateway processor. The gateway processing translates data into a format that would be compatible with the receiver's message format. Data to exchange between Link 16 and VMF might be: location of friendly ground troops around the target and location of enemy air defenses. The 9 line CAS message by voice provides target information and updated information about enemy air defenses around the target area.

A gateway provides joint interoperability for data sharing and battle space visualization. A gateway can be **software only, or hardware with software**. As hardware, it can be a stand alone laptop or a physical card that gets inserted into another computer on the platform. In order for gateways to function, you need both data link radios/antennas to participate in both networks. The information that gets shared can then go over each network to their participants. Line of sight limitations for Link 16 and VMF network participants can impact gateway placement. A one way gateway is easier to conceptualize and implement than a two way gateway. Link 16 is a near real time network and passing information from Link 16 to VMF, and back again, with the corresponding translation, takes several seconds for the data transfer. This factor (timing within the mission context) is a critical consideration in gateway designing.

Gateways must have a network interface with rules for message handling. They require infrastructure support, including configuration management. Gateways have several important characteristics: they translate messages from one message format to a data base and from the data base to another message format. Gateways enable digital C2 and situation awareness across multiple data links. Messages may not be translatable on a 1-to-1 data link basis.



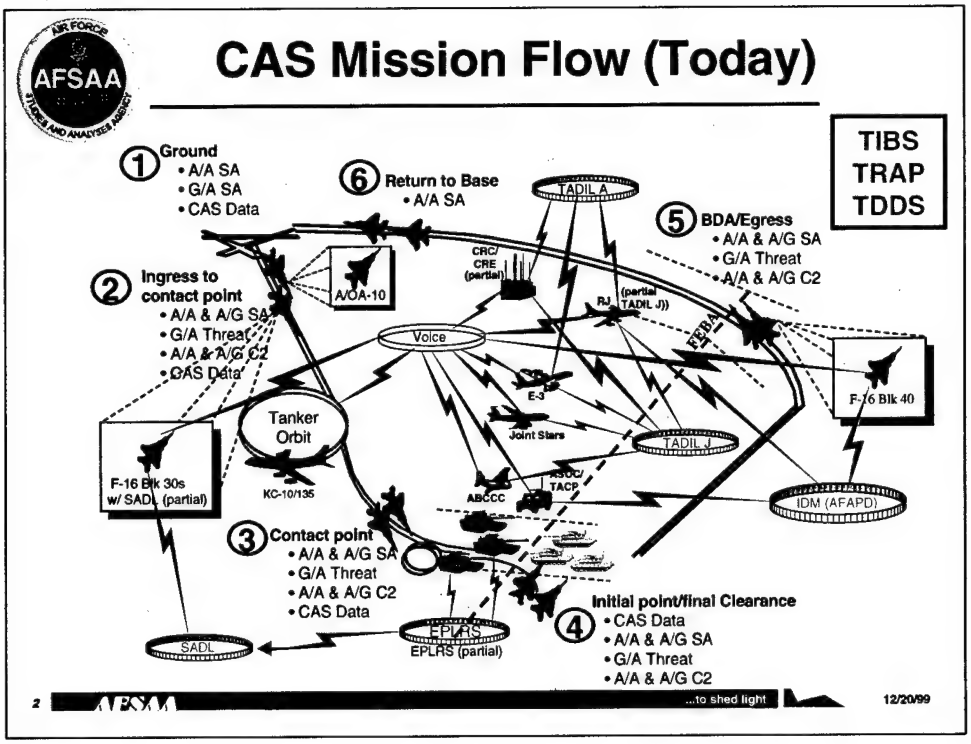
In the Air, on land, on the sea and in the Intel domain, we have developed point solutions of different data links with different protocols. Each domain created a stovepipe solution. In the Air, data links are standardizing to Link 16. Other domains are migrating to standard systems also. In order for these standard systems to digitally exchange data, they need gateways.

U.S. ground air defense systems are now data linked using **Link 11B** with TADIL B messages. Link 1 is a lesser capable, but similar, point-to-point link. For mobile air defense systems, the U.S. uses **Link 11** with TADIL A messages. The Navy implementation of Link 11 is in Airborne Tactical Data Systems (ATDS) for P-3 and E-2C. NTDS (Navy Tactical Data Link System) is only for Navy ships. Link 11 and 11B allow integrated data link operations between air and sea (Link 11), and land based (Link 11B) tactical data systems. The Air Force implements additional Navy capabilities using **Link 4A** with TADIL C messages. Link 4A provides digital surface-to-air, air-to-surface, and air-to-air tactical communications. It has a reputation for being reliable, though it's transmissions are neither secure nor jam resistant. It is easily operated and maintained without serious or long-term connectivity problems. The Army uses **Link 11B** and **Link 16** to jointly connect in the air defense mission. While the end goal for a common joint theater data link is **Link 16**, we have several interim capabilities, such as **IDM (AFAPD)** [Improved Data Modem - Air Force Application Program Development {AFAPD is one of the sets of messages/protocols used over IDM}], **SADL** (Situation Awareness Data Link), and **IJMS** (Interim JTIDS Message Specification).

DoD is digitizing other domains and mission areas. On land, the Army plans to transition to a Tactical Internet using Variable Message Format (**VMF**) messages. At sea, the Navy is adding Cooperative Engagement Capability (CEC) which is expected to transition to the evolving Joint Composite Tracking Network (JCTN). Link 16 is the common joint tactical data link for the future.

The Intelligence area is automating its domain, having **Integrated Broadcast Service (IBS)** as an end goal.

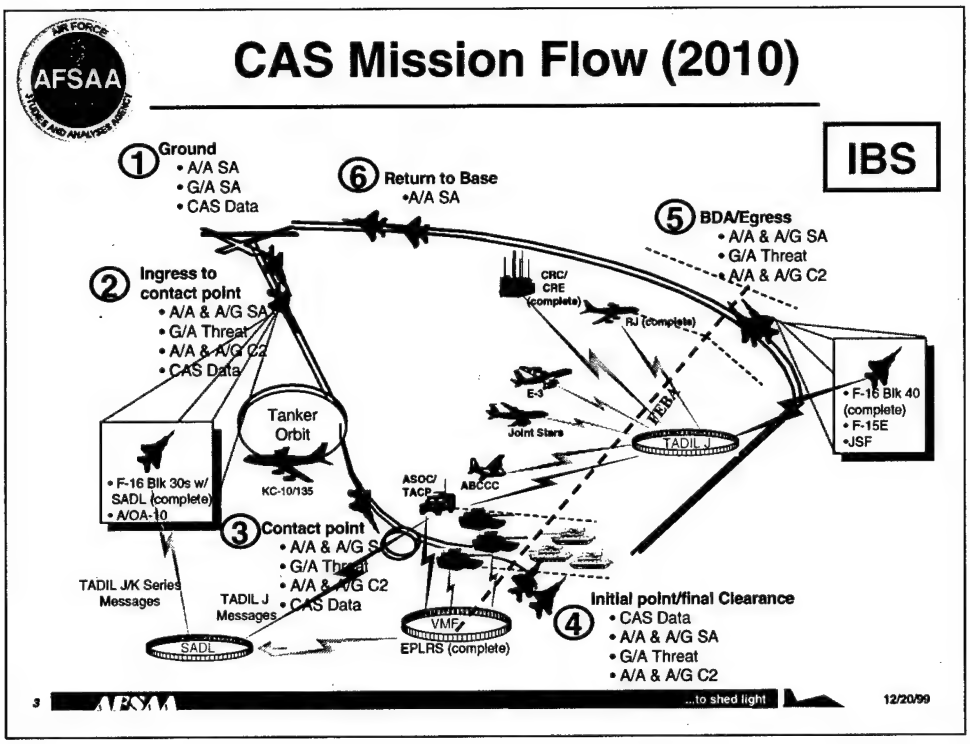
BACK-UP SLIDES



The purpose of this figure is to relate the complexity of the Close Air Support (CAS) mission with today's digital data systems and voice communications. From the point of view of the pilot, there is needed information for the mission, as well as needed information updates. Right now, the primary communication is voice -- as it is ubiquitous in connecting the warfighters. This reliance on voice has perpetuated for thirty years, and is about to be able to be overcome by the connectivity now allowed by multiple digital data link connections inherent in gateway technologies.

The above figure shows the progress of a typical CAS mission with the major categories of Information Exchange Requirements (IERs) at each phase of the mission. From data communications point of view, today's CAS missions lack ground-to-air (G/A) situational awareness (SA). By incorporating SADL onto F-16 Blk 30's, A/G SA will improve considerably. To date, there are approximately 242 out of 516 F-16 Blk 30s with SADL capability (FY 1999). Most information exchange requirements are executed through voice (HF, VHF, and UHF HAVEQUICK). Only three platforms have TADIL J capability. Approximately 1/3 of the EPLRS systems will be fielded (FY 1999) and they will generate EPLRS position reports.

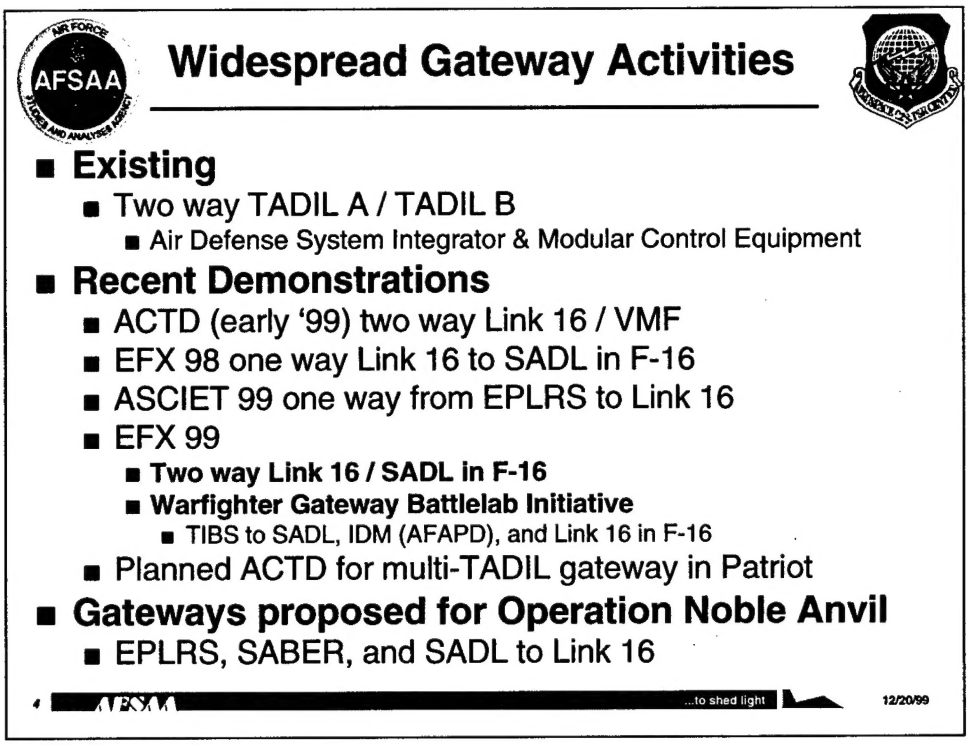
The CAS mission today uses multiple data links and voice. Voice is the primary means to convey the 9 line CAS message to help the aircraft sort out friendly and enemy positions as well as to provide to the pilots updated information about the target.



By 2010, all Air Force CAS-related systems will be using TADIL J messages. IDM (AFAPD) migration to TADIL J is scheduled to be completed in 2008.

Gateways will still be needed between IBS and the TADIL J networks, and between VMF (as used in the Army's planned Battlefield Tactical Internet) and TADIL J.

Not shown on this chart is that voice connectivity between the CAS mission players is planned to still exist in 2010. Also, TADIL A will be available to CRC/CRE (or the Battlefield Control Center [BCC] as it may be called), Rivet Joint and AWACS E-3 aircraft as a back-up data link.

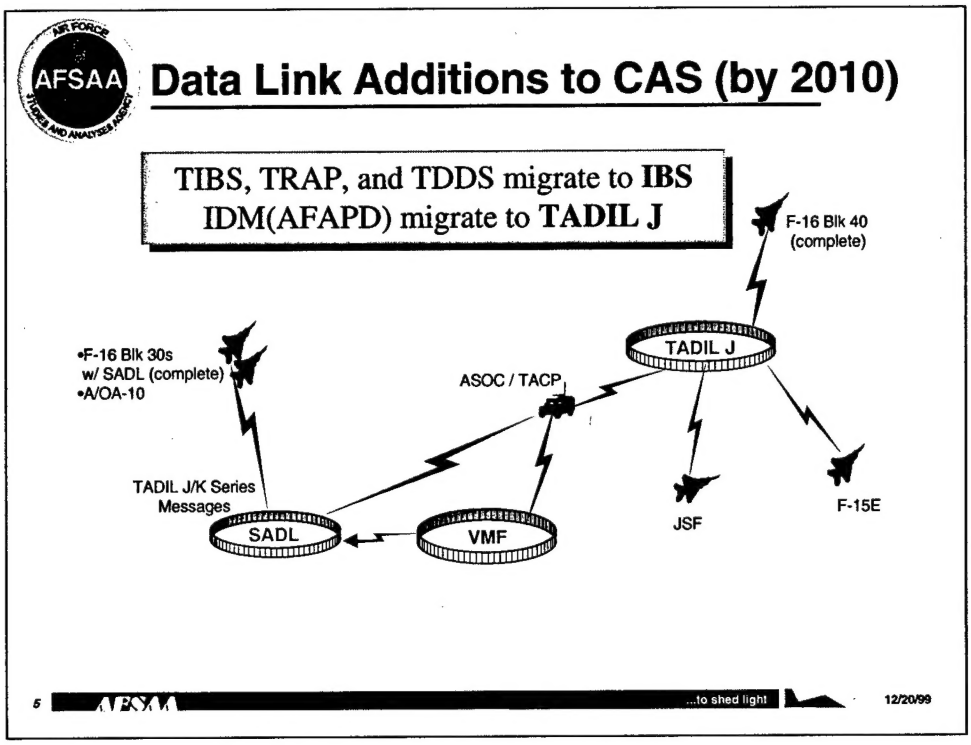


Gateways provide a means to transfer data link information between separate data links. The TADIL A to TADIL B gateway is used for C2 and air defense operations. We are going to be adding gateways in the future (note the proliferation of technology demonstrations which clearly supports the notion that gateway technology has advanced.) We can either go for an organized, integrated gateways solution or we can continue down the road we're on by developing multiple gateways as point solutions.

The two way TADIL A to TADIL B gateway exists and has existed for over a decade. It uses a guiding document of over eight hundred pages for data forwarding rules. A gateway exists in the Air Defense System Integrator (ADSI) located in the ground Modular Control Equipment (MCE) for the air war. This gateway allows information transfer for air defense and C2 for weapons control.

The Advanced Concept Technology Demonstration (ACTD) of Link 16 to/from Variable Message Format (VMF) was successful for two separate vendor teams. It allowed information exchange of air and ground force data to build situation awareness and exchange of Command and Control messages. Other demonstrations of gateways have been successful. Another ongoing activity is to try to push gateway technology onto the warfighters currently operating in the European theater.

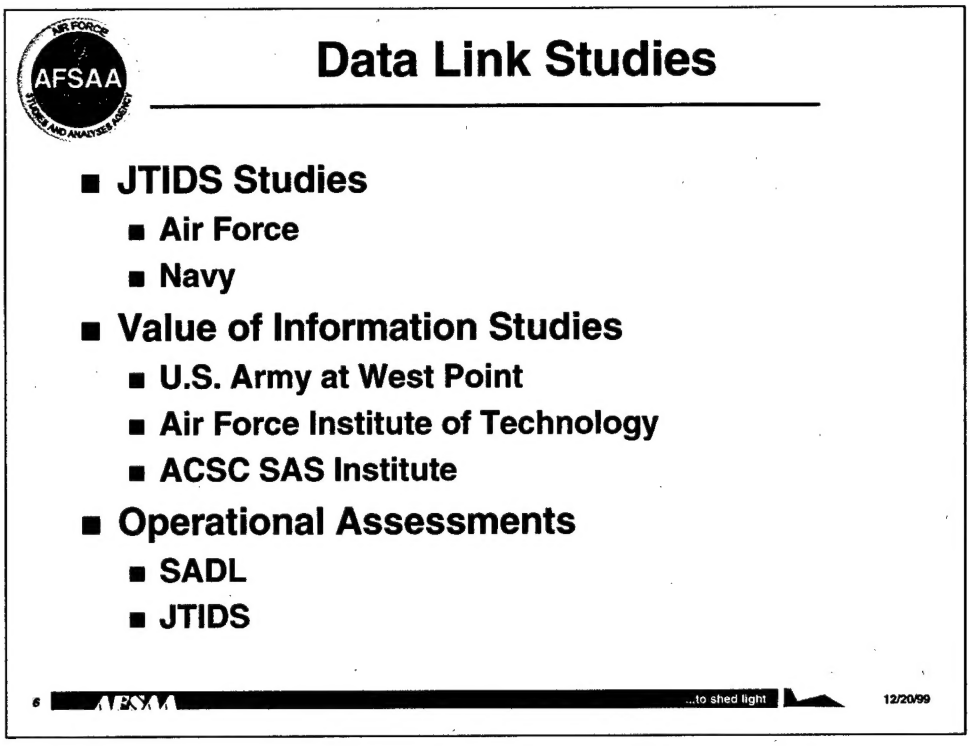
SABER is Situational Awareness Beacon with Reply. SABER is a battle group situation awareness system capable of determining the location of beacon equipped tanks, ships, aircraft, and other military assets worldwide. Using the Global Positioning System (GPS), SABER produces accurate position and platform identification data and sends that information to tactical users and global command and control nodes, where it can be shared to enhance overall communications during military operations. The system relays position information via ultra-high frequency (UHF) line-of-sight and UHF satellite communications (SATCOM) channels.



Today, TADIL J connects AWACS (E-3), ABCCC, Rivet Joint, CRC/CRE and Joint STARS. By 2010 TADIL J will be used by ASOC/TACP, F-15E, JSF and F-16 Block 40 aircraft. By 2010 VMF will be used to connect Army ground units. The AF ASOC/TACP will also be VMF capable. All F-16 Block 30 and A/OA-10 aircraft will have SADL to transmit/receive TADILJ and receive K-series messages.

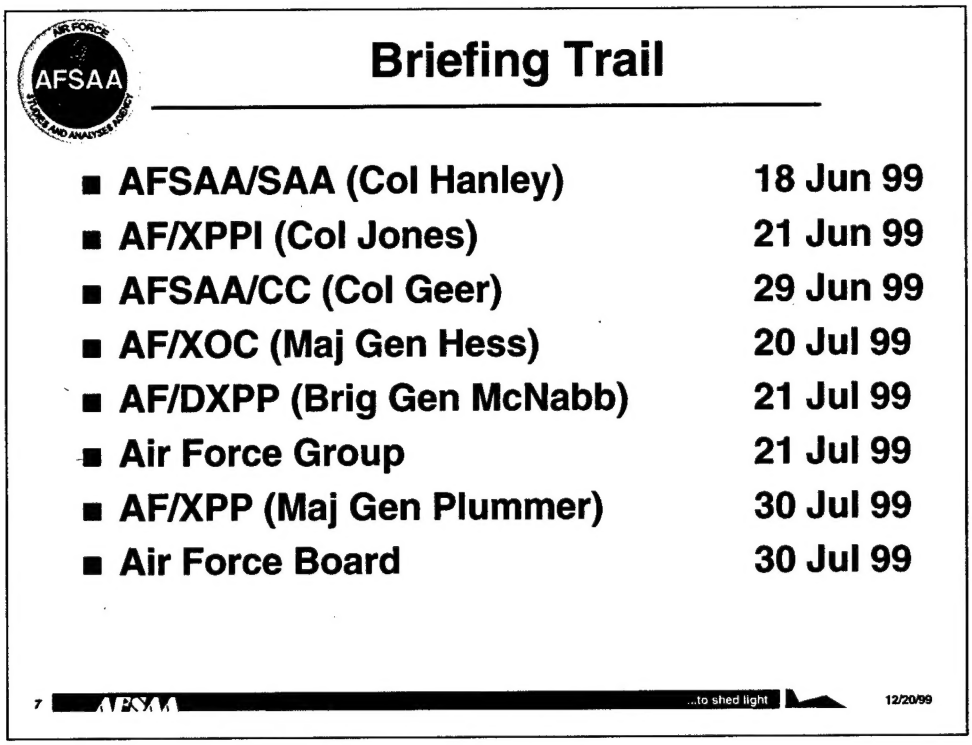
Today, VMF connects Army ground units. In 2010, VMF will be added to ASOC / TACP.

All F-16 Block 30 aircraft will have SADL and A/OA-10's will have SADL to get TADIL J and K series messages.



There is evidence of improved performance on the battlefield with digital data links. Situation awareness was shown to be enhanced, with a decrease in verbal updates, particularly relating to position and fuel updates, resulting in better performance, as shown in the following studies and operational assessments:

- *Joint Service Study of JTIDS*, AF/SA, Aug 80, SECRET
- *JTIDS Operational Applications Study*, TAFIG, Dec 83, SECRET
- *MIDS in Air Combat Simulation*, SHAPE, May 86, UNCLASSIFIED
- *AF IOT&E of JTIDS Class 2 Terminal*, AFOTEC, Aug 87, SECRET
- *JTIDS Theater Air Defense Support Evaluation*, AFCSA/SAGR, Dec 87, SECRET
- *Assessment of JTIDS Operational Performance in the F-15 Theater Counter Air Mission*, Teledyne Brown, Oct 88, UNCLASSIFIED
- *Normative Outer Air Battle (OAB) Scenario for JTIDS Utility Evaluation*, MITRE, Sep 90, SECRET
- *JTIDS OAB Experimental Report*, Naval Ocean Systems Command, Oct 90, SECRET
- *The Contribution of JTIDS in Improving F-14 Missile Firing Effectiveness*, MITRE, Dec 90, CONFIDENTIAL
- *JTIDS Contribution to Fighter-to-Fighter Coordination in the OAB*, Naval Weapons Center, Jan 91, SECRET
- *Link 16/JTIDS Military Utility/Worth Analysis for Anti-Air Warfare*, TASC, May 91, SECRET
- *Effects of Alertment on Allocation of Fighter Assets: An Analysis of a RESA Simulation with JTIDS*, MITRE, Jun 91, CONFIDENTIAL
- *Utility of a Data Link to Fighters*, MITRE, Sep 91, UNCLASSIFIED
- *Cost and Operational Effectiveness (COEA) of the Multifunctional Information Distribution System (MIDS) for Milestone II*, MIDS COEA Study Team, May 93, SECRET
- *Exploring a Relationship between Tactical Intelligence and Battle Results*, USMA (West Point), 1996, UNCLASSIFIED
- *A Methodology to Assess the Value of Communications Systems*, USAF ACSC (SAS), 1998, UNCLASSIFIED
- *Calculating a Value for Dominant Battlespace Awareness*, AFIT thesis, 1998, UNCLASSIFIED
- *Demonstration Report for SADL Operational Assessment During NTC 97-11*, AFOTEC, Feb 98, FOUO



This slide shows who has been and who is planned to be briefed for AFSAA management. AF/XPP will decide if it will get presented to the Air Force Group. Based on feedback from the Air Force Group, AF/XPP will decide if this brief goes to AF/XP and to the Air Force Board. This presentation satisfies Col Jone's request of AFSAA to create a gateways introductory brief. It is being used by the AC2ISRC as an introduction, and slides from this brief have been used by SAF/AQII to brief AF/CC, Gen Ryan, on the Data Link Roadmap which relies on gateways to translate between different digital data links.